

REMARKS

This amendment is in response to the final Office Action received in the above-referenced application. Applicant respectfully requests that the Examiner consider the proposed amendments to claims 1, 6, 8, 10, 12, 14, and 15. Claims 2, 5, 7, 9, and 13 have been cancelled.

With respect to all amendments and cancelled claims, Applicant has not dedicated or abandoned any unclaimed subject matter. Applicant reserves the right to pursue prosecution of any presently excluded claim embodiments in future continuation and/or divisional applications.

Claim 1 has been amended to more clearly point out and distinctly claim the subject matter of the present invention. Specifically, claim 1 has been amended to recite that the "metal silicate layers each have a thickness and a dielectric constant lower than the metal oxide layer." Support for this proposed amendment is found throughout the specification and figures, for example, in page 5, lines 15-17 and in Figure 3. Applicant respectfully submits that no new matter is added by this proposed amendment. Claim 6 has been amended to clarify that the metal oxide layer comprises a metal oxide and that the metal silicate layer comprises a metal silicate. Claims 8, 10, 12, 14, and 15 are amended to correct changes in dependency given the amendments to the claims made herein.

Claim Rejections Under 35 U.S.C. §103(a)

The Examiner has rejected claims 1, 3-4, 6, 8, 10-15 under 35 U.S.C. §103(a) as unpatentable over Callegari, in view of Steigerwald et al. ("Steigerwald"). Applicant disagrees and respectfully traverses the rejections.

To establish a proper prima facie case of obviousness, three criteria must be met. First, there must be some suggestion or motivation, either in the cited references themselves or in the knowledge generally available to one of ordinary skill in the art, to modify or combine the cited reference relied upon by the Examiner to arrive at the claimed invention. Second, there must be

a reasonable expectation that the suggested modification or combination would be successful. Finally, the prior art reference (or references when combined) must teach or suggest each and every limitation of the rejected claims. The teaching or suggestion to make the claimed modification or combination and the reasonable expectation of success must both be found in the prior art, and not based upon in the applicant's disclosure. M.P.E.P. §706.02.

Applicant respectfully submits that the combined references do not teach or reasonably suggest Applicant's proposed amended claims. In particular, the combined references do not teach or suggest forming a metal oxide layer in between two metal silicate layers, "wherein said metal silicate layers each have a thickness and a dielectric constant lower than the metal oxide layer" (proposed amended claim 1).

Callegari's teaching is limited solely at a high-K dielectric layer sandwiched between two optional layers, with no suggestion, motivation, or teaching regarding the thickness or the dielectric constant of the layers. Callegari simply teaches that "the middle layer, 56, is a high-K dielectric layer" (Callegari, col. 11, lines 36-37) and that "[T]he multilayer gate dielectric 53 is comprised of an optional upper layer, 57 which act as a dopant diffusion barrier and stabilize the structure of the gate electrode 52. An optional lower layer 55 which may act as an electron barrier layer and as a layer to prevent oxidation of the underlying silicon during processing or both" (Callegari, col. 11, lines 30-36).

In describing the materials that may form the layers in the multilayer dielectric disclosed therein, Callegari states that "[A] suitable lower layer 55 is composed of dielectric materials including, but not limited to: SiO_2 , SiO_xN_y , or Si_3N_4 , prepared from oxidation or nitridation of the silicon substrate or deposited separately. Other suitable lower layer materials include metal oxides or metal silicates. The high-K dielectric layer 56 is selected from the group consisting of aluminum oxide or a multilayer structure where at least one of the layers is aluminum oxide" (Callegari, col. 11, lines 37-44). "The optional upper layer 57 may be an oxidized or nitrided

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surface of the middle layer, 56, or a deposited dielectric material including, but not limited to: SiO_2 , SiO_xN_y , Si_3N_4 , ZrO_2 , HfO_2 , aluminum oxide, aluminosilicate, yttrium silicate, zirconium silicate, hafnium silicate, lanthanum silicate doped or undoped mixtures, layers, or combinations thereof" (Callegari, col. 11, lines 54-60).

There is no explicit requirement in Callegari that the optional lower and upper layers be composed of a metal silicate material nor that they be thinner or have a dielectric constant lower than the middle layer. In fact, Callegari contemplates having the optional lower and upper layers be of the same aluminum oxide material as the middle layer, thereby having the same dielectric constant and potentially the same thickness.

In contrast, the present invention explicitly suggests that "[P]preferably, the thickness of the first layer 12 of the multilayer dielectric film 5 is formed greater than the thickness of the second layer 14 in order to promote a high dielectric value for the entire dielectric structure" (specification, page 5, lines 15-17). Callegari does not teach having the middle layer be thicker than the optional lower and upper layers to "promote a high dielectric value for the entire dielectric structure;" rather, it teaches simply that the middle layer be formed of at least one layer of aluminum oxide, a material that has a high dielectric constant.

Accordingly, Callegari does not disclose, teach, or suggest forming the layers at a particular thickness or dielectric constant. While the present invention teaches, for example, using materials with a dielectric constant in a range of 15 to 200 for the metal oxide layer at a thickness in a range of 30 to 80Å and a dielectric constant in a range of 5 to 100 for the metal silicate layers at a thickness of one to two atomic layers (claims 6, 14, and 15), Callegari is silent on what ranges of dielectric constants or thickness of the layers are appropriate or recommended for its multilayer dielectric other than requiring at least one layer of aluminum oxide in the middle layer.

As such, one of ordinary skill in the art would not be able to draw any conclusions as to what ranges of dielectric constants or thickness of the layers to use based on the suggestions given in Example 5 and Figures 12A-12H of Callegari (col. 11, line 17 to col. 12, line 17). As described in the specification of the present invention, the structure of the multilayer dielectric is such "that it can significantly improve the stability of the high K dielectric film against changes during further device processing which would degrade the effectiveness of the high K dielectric film" (specification, page 7, lines 15-17). "The use of the multilayer dielectric film of the present invention, such as a metal silicate/metal oxide/metal silicate stack will resist the device degradation to a higher anneal temperature" (specification, page 7, lines 28-30). "Where the metal oxide is contained between layers of metal silicate which act as a buffer or interface layer to the silicon, the structure resists degradation to a higher temperature" (specification, page 8, lines 7-9).

There is no suggestion in Callegari that the multilayer dielectric disclosed therein be of a metal silicate/metal oxide/metal silicate structure with the dielectric constant and thickness configuration taught in the present invention so as to improve the dielectric's resistance to higher temperatures at further device processes. Callegari does not disclose, teach, or suggest any particular dielectric constant and thickness configuration that will make its dielectric more resistant to higher temperatures.

The Examiner's suggestion that "Callegari also implied that said metal silicate layer has a dielectric constant lower than the dielectric constant of said metal oxide layer because, layer 56 of metal oxide has high dielectric constant while the other two may not" (Office Action, paragraph 4, page 3) is at best, inappropriate hindsight. The fact that the middle layer has a high dielectric constant does not automatically suggest or imply that the optional lower and upper layers have lower dielectric constants. As stated above, Callegari even contemplates that the three layers have the same dielectric constants and be formed of the same aluminum oxide material. There is no disclosure, teaching, or suggestion in Callegari that the optional lower and

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upper layers be formed of a metal silicate at a dielectric constant and at a thickness lower than the middle layer.

Applicant further respectfully submits that Steigerwald adds nothing more. Steigerwald teaches a process for device fabrication where an organic precursor gas and an inorganic precursor gas are introduced into the chamber. The organic precursor gas catalyzes a reaction between the inorganic precursor gas, the organic precursor gas, and the substrate to form a dielectric layer without forming an interface layer of metal, silicon, and oxygen (Steigerwald, col. 6, lines 5-20). Steigerwald does not teach or reasonably suggest a method of forming a multilayer dielectric film with specific layers of a particular composition in a particular arrangement as recited in Applicant's claims. Steigerwald's motivation focuses on teaching types of precursors with particular reaction kinetics that prevent the formation of undesirable interface layers, particularly oxygen-containing organic precursors that do not favor a reaction with the substrate to form an oxidized semiconductor compound (Steigerwald, col. 2, lines 17-20, col. 3, lines 16-20, and claim 1, among others).

Applicant respectfully submits that Callegari and Steigerwald, either alone or in combination, do not teach or reasonably suggest Applicant's amended claims. Further, Applicant does not see the motivation to combine Steigerwald and Callegari. Callegari teaches certain aluminum alkoxide precursors that are dissolved, emulsified or suspended and then vaporizing such aluminum alkoxide precursors to form an aluminum oxide film at a temperature greater than 500 °C. Steigerwald describes organic oxides as precursors such as alkyl oxides, alkyl phosphine oxides, alkyl sulfoxides and heterocyclic oxides, such as oxanorbomene and oxanorbomadiene. Steigerwald further teaches that temperature, particularly the decomposition temperature (or cracking temperature) of the organic and inorganic precursors is important to achieve the stated purpose of preventing formation of an interfacial layer (Steigerwald, col. 6, lines 24-45). Steigerwald goes on to describe various cracking temperatures of the suitable precursors at col. 6, lines 45-67 and at col. 7, lines 1-5. All of the recited temperatures are considerably below 500 °C – the temperature “*floor*” taught by Callegari. Applicant respectfully submits that Callegari and Steigerwald are two very distinct process with different purposes and

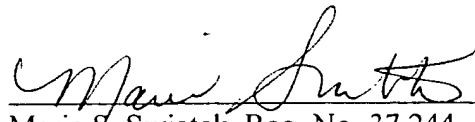
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that there is no motivation to combine them. Assuming *arguendo*, even if one were to combine Callegari and Steigerwald as the Examiner suggests, one would not arrive at Applicant's claims.

Applicant respectfully submits that the application is in condition for allowance. If any matters can be resolved by telephone, the Examiner is invited to call the undersigned attorney at the telephone number listed below. Commissioner is authorized to charge any additional fees to Deposit Account No. 50-2319 (Order No. A-70028-1/MSS (463035-936)).

Respectfully submitted,



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